# *Scleral Lens Induced Corneal Edema due to Poor Oxygen Transmissibility*

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## Background

- 71 year old Native American male
- Medical History:
  - *Diabetes Type II
  - *Hypertension
  - *Benign Prostate Hypertrophy
- Ocular History: Keratoconus OU
- Medications: Toujeo, Metformin, Lisinopril, Amlodipine, Finestaride
- Other information: No primary care physician for the past 1-2 years

## Case Details

**Initial Visit**

**Chief Complaint:**
Presented on 10/4/16 with lens discomfort and decreased vision OS. Started 4 days ago and has discontinued lens wear since.

**Visual Acuities:**
*OD: 20/50 PH 20/40
*OS: CF PH 20/150

**Contact Lens History:**
Jupiter scleral contact lens (Fit characteristics shown in Table 1)
-Patient currently using Clear Care for cleaning and preserved Equate Saline to fill lenses.

| Table 1 | Central Clearance | Limbal Clearance | Landing Zone | Central Thickness |
|---|---|---|---|---|
| OD | 250 um | 50 um<br>100 um inferior | Trace blanching | 350 um |
| OS | 200 um | 50 um<br>100 um inferior | Trace Blanching | 350 um |

**Table 1 Initial lens fit characteristics**

| Dk=150 | Clearance (μm) | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
|---|---|---|---|---|---|---|---|---|
| Lens thickness (μm) | | | | | | | | |
| 250 | | 34.3 | 28.2 | 24.0 | 20.9 | 18.6 | 16.6 | 15.0 |
| 300 | | 30.8 | 25.8 | 22.2 | 19.5 | 17.4 | 15.7 | 14.3 |
| 350 | | 27.9 | 23.7 | 20.7 | 18.3 | 16.4 | 14.9 | 13.6 |
| 400 | | 25.5 | 22.0 | 19.3 | 17.2 | 15.6 | 14.2 | 13.1 |
| 450 | | 23.5 | 20.5 | 18.2 | 16.2 | 14.8 | 13.5 | 12.5 |
| 500 | | 21.8 | 19.2 | 17.1 | 15.5 | 14.1 | 13.0 | 12.0 |

: satisfies HM criteria
: satisfies HM and HB criteria

**Table 2 Predicted Dk at the center thickness with OD and OS highlighted**

**Pertinent exam findings:**
**Cornea:** OD Edema centrally over cone and peripherally with 2+ SPK
OS Edema centrally over cone and peripherally (greater than OD) 3+ SPK

**Plan:**
Discontinue preserved filling solution and replace with non-preserved 0.9% Sodium Chloride solution. Keep patient out of OS lens and remove OD lens as much as possible. Rx heavy artificial tear use.

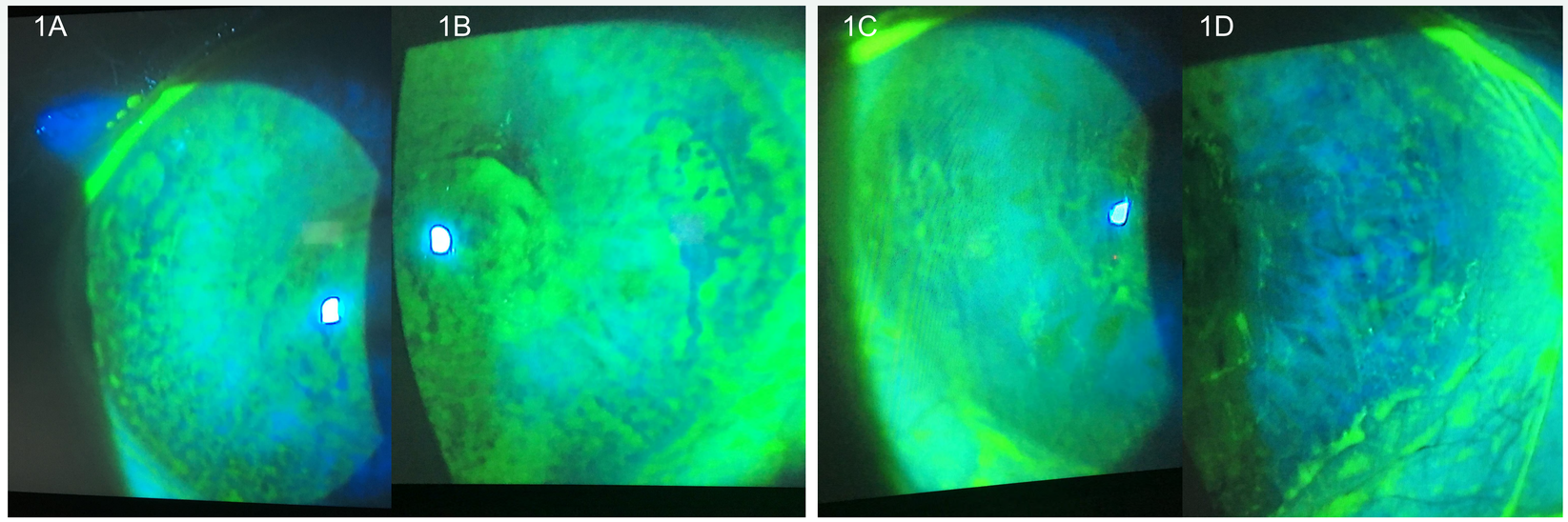
**Second Visit 10/6/2016**
RE returns with lenses on to assess fit and recheck corneal findings.

**Pertinent Exam findings**
OD & OS SPK had improved slightly, patient still having large amount of microcystic edema with “whirl” edema.

**Plan:**
Refit scleral lens with less central thickness and central vault to allow for more oxygen to cornea throughout the day. Patient is to remove one lens two hours before sleeping and alternate between each eye every other night.

## Findings

*Temporal* OD *Nasal* *Nasal* OS *Temporal*




**Images 1 A-D picture RE cornea on 11/22/2016. Large amount of edema with 1-2+ SPK**

| A | Material | BC | Power | Diam | Center Thickness |
|---|---|---|---|---|---|
| OD | Menicon Z<br>Dk 163 | 6.69 | -9.75 | 15.6 | 300 um |
| OS | Menicon Z<br>Dk 163 | 7.03 | -10.50 | 15.6 | 300 um |

**Table 3 A) Final lens parameters B) Final fitting characteristics**

| B | Central Clearance | Limbal Clearance | Landing Zone |
|---|---|---|---|
| OD | 150 um | 50 um | Trace blanching |
| OS | 150 um | 50 um | Trace blanching |

| Dk=170 | Clearance (μm) | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
|---|---|---|---|---|---|---|---|---|
| Lens thickness (μm) | | | | | | | | |
| 250 | | 36.7 | 29.9 | 25.2 | 21,7 | 19.1 | 17.1 | 15.5 |
| 300 | | 33.1 | 27.5 | 23.4 | 20.4 | 18.1 | 16.3 | 14.8 |
| 350 | | 30.2 | 25.4 | 21.9 | 19.3 | 17.2 | 15.5 | 14.2 |
| 400 | | 27.8 | 23.6 | 20.6 | 18.2 | 16.3 | 14.9 | 13.6 |
| 450 | | 25.6 | 22.1 | 19.4 | 17.3 | 15.6 | 14.2 | 13.1 |
| 500 | | 23.8 | 20.8 | 18.3 | 16.5 | 14.9 | 13.7 | 12.6 |

: satisfies HM criteria
: satisfies HM and HB criteria

**Table 4 highlights the predicted Dk/t through the center of the final lenses**

## Treatment and Management

The need for more oxygen to the cornea led to the necessity for a refit of the scleral lens. This led to the instruction of the patient to remove one lens two hours before sleeping and alternate between the eyes each day. Artificial tear use was prescribed to assist with the heavy SPK. After a few months of questionable compliance, a better fitting lens, and no significant corneal improvement, the patient was refit in a hybrid contact lens.

## Diagnosis and Discussion

The final diagnosis was longstanding corneal edema due to hypoxia caused by a scleral contact lens.

A scleral contact lens is a medical device used to correct vision by masking corneal irregularity. With its rigid surface and large lacrimal lake, a scleral lens is intended to reduce glare and distortion. Unfortunately, as scleral contact fittings become more common, so do their ocular complications.

As Michaud et al describes, a major issue concerning the thickness of the scleral lens design and tear film involves a decreased amount of oxygen transmissibility. This concern is amplified as the target scleral lens population often have compromised corneas that require adequate oxygen.

As shown by Harvitt and Bonanno, an average cornea needs a central Dk/t of 35. Tables 2 and 4 can be used to calculate the approximate central Dk/t. For this particular patient, neither the initial lens nor the final lens met the HB criteria.

Additionally, the thickness of scleral lenses tends to increase towards the mid periphery, especially for highly myopic designs. This also decreases the Dk/t at the limbal area, leading to the possibility of limbal stem cell deficiency.

In conclusion, even if optically optimal, it is important to recognize when a particular contact lens is no longer healthy for a patient with corneal irregularity or ocular surface disease. If lack of oxygen transmissibility is suspected with a scleral contact lens, other designs such as corneal RGPs or hybrid contact lenses should be explored.

## References

Bennett, Edward S., and Vinita Allee. Henry. "Section IV." *Clinical Manual of Contact Lenses*. 4th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins, 2014. 444-47. Print.
Kaiser. "Cornea." *The Massachusetts Eye and Ear Infirmary Illustrated Manual of Ophthalmology*. 4th ed. N.p.: Elsevier, 2014. N. pag. Print.
Harvitt DM, Bonanno JA. Re-evaluation of the oxygen diffusion model for predicting minimum contact lens Dk/t values needed to avoid corneal anoxia. Optometry and Vision Science 1999;76(10):712–9.
Michaud, Langis, Eef Van Der Worp, Daniel Brazeau, Richard Warde, and Claude J. Giasson. "Predicting Estimates of Oxygen Transmissibility for Scleral Lenses." *Contact Lens and Anterior Eye* 35.6 (2012): 266-71. Web.
Yanoff, Myron, and Jay S. Duker. "Contact Lens-Related Complications." *Ophthalmology*. 3rd ed. Philadelphia, PA: Elsevier Saunders, 2014. 280-89. Print.

Heart of America Contact Lens Society, 2017